Developmental Evaluation & Test for Decision Support *or* First the "E" then the "T" in T&E

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MITRE Support to DASD(DT&E)

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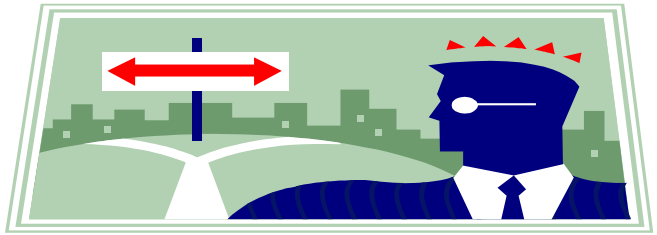
Purpose & Overview

- **TEMP should articulate a logical *evaluation* & test plan that informs the program's decisions**
  - **Evaluation Framework describes**
    - **how the system's capabilities will be (independently) evaluated**
    - **against the appropriate requirements document**
    - **to inform the program's acquisition and operational decisions**
  - **Test design developed after EF**
    - **to provide performance data (for evaluation)**

DT&E: First focus on the "E"; then plan the "T"

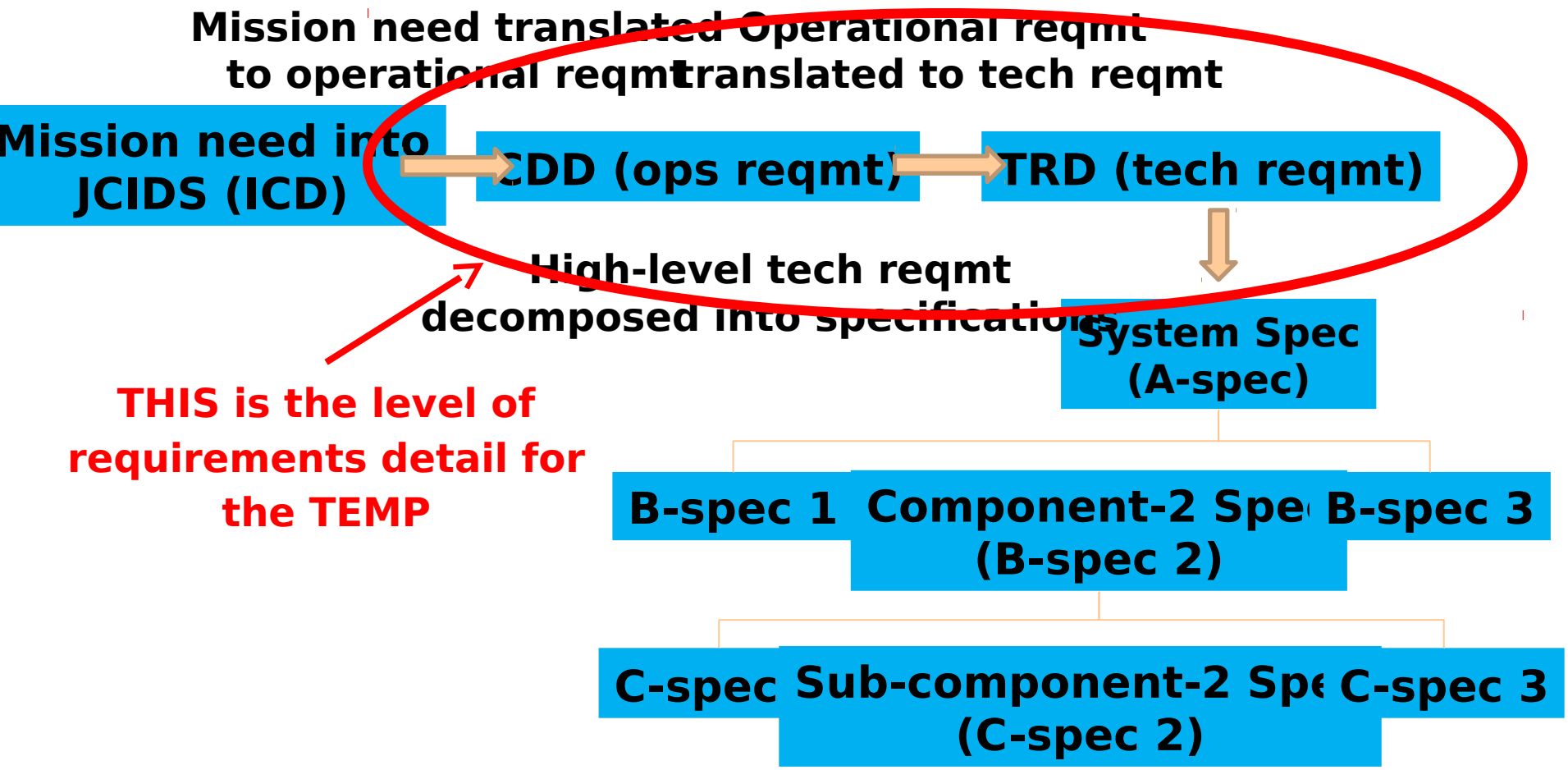
Why Focus on Evalua

- Testers naturally want to *test…*
- *BUT,* T&E's purpose is to inform – decisions, product development, etc.
- SO, first step should be to define an *evaluation* strategy
  - How to evaluate the system's performance against its requirements?
- *THEN,* define the *test* events that will generate data to feed the system evaluation
- *…to inform the decisions that need to be made*



uate system performance against relevant requireme

Requirements -- from Ops to Tech



THIS is the level of requirements detail for the TEMP

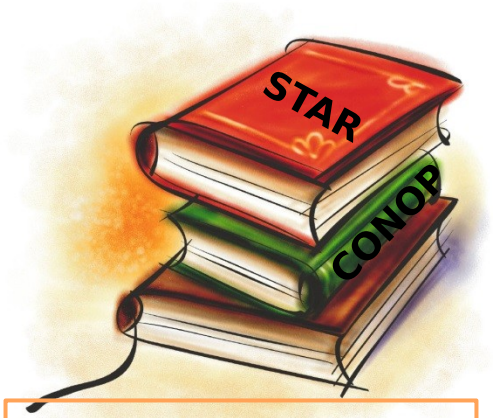
Evaluate Against Relevant Requirements (in mission context)

Operational T&E

Govt Developmental T&E

CDD (ops reqmt)

TRD (tech reqmt)



Mission Context

A-spec

B-spec 1 B-spec 2 B-spec 3

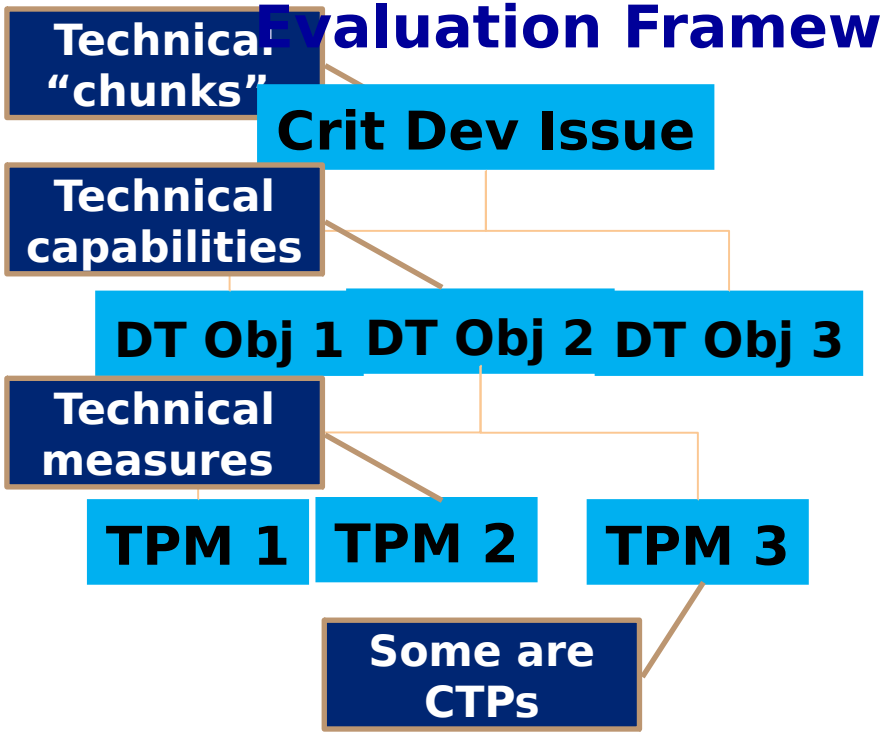
C-spec 1 C-spec 2 C-spec 3

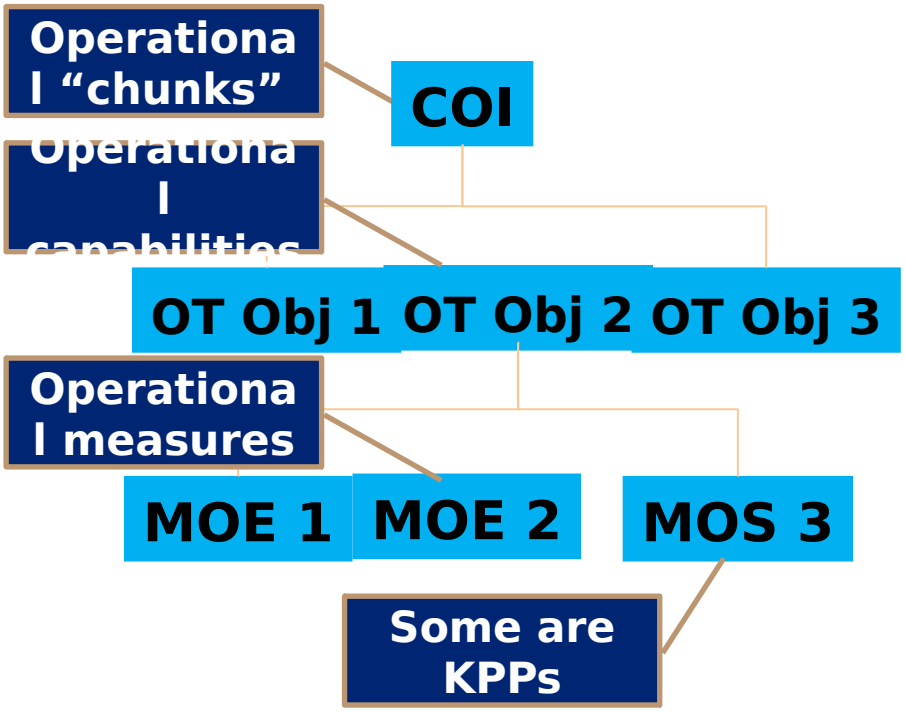
Contractor T&E

Plan Evaluation, Then Test…

Tech Reqmt → DT → Ops Reqmt → OT Framework

Evaluation Framework





Notes:

1. CDD translated into tech requirements in TRD
2. CDI focused on decision-maker information needs
3. DT objectives are tech capabilities (TRD para headings)
4. Some measures (TPMs) are more important (CTPs)

Notes:

1. Ops requirement from JCIDS doc (CDD)
2. OT objectives are logical ops sub-functions of COI and logical grouping of lower-level measures

(AFOTEC nomenclature: OT objective = Operational Capability)

3. Some MOE/MOS are KPP/KSA

Matrix EF Quickly Communicates Evaluation Pl

Information from CDI #1, 4, 6 will be used to inform the radar production decision

Critical Developmental Issues (CDI) are questions linked to acquisition strategy decisions

DT Objectives (from TRD paragraph headings) represent technical capabilities

Cell content is Technical Performance Measures (TPM) Critical Technical Parameter (CTP) Highlighted/emphasized

Critical Developmental Issues / Developmental Test Objectives	**CDI #1:** Does the radar provide coverage, sensitivity, and accuracy sufficient to detect and track LEO and MEO objects?	**CDI #2:** Is the radar data processing, handling, and storage sufficient to characterize, correlate, track, and report space objects?	**CDI #3:** Are command and control and interfaces sufficient to provide tasking to the radar and surveillance information to the SSA customer	**CDI #4:** Are environmental effects sufficiently planned for and executed?	**CDI #5:** executed … information protections sufficient to ensure information assurance and physical security?	… balanced with other design factors sufficient to provide a reliability, maintainable, available, and economical system?
Radar coverage						
Radar …						
Observation accuracy	…e (az/el) accuracy ***Range accuracy** ***Time accuracy** ***RCS accuracy** ***Obs tagging integrity** (includes correlate & tag)					
System calibration	Atmospheric calibration Systematic error calibration RCS calibration Radar calibration					
Surveillance and Characterization process		Metric obs formation and dissemination RCS determination and dissemination Space object identification				

Developing the DT EF

Each T&E community, requirements in hand, develops their independent evaluation framework, DT&E'ers:

1. **Identify the proper technical reqmt do & SME's**
   - **"High level" (CDD-equivalent) requirements document**
     - **Space Fence: Technical Requirements Document (TRD)**
     - **SBIRS: System Requirements Document (SRD)**
     - **GPS: SYS-800 Enterprise-Level Specification**
2. **Develop Critical Developmental Issues (CDI)**
   - **Key decision-maker wonderments**
   - **Needed information from DT&E to inform program acquisition or operational test readiness certification decisions**
     - **OT readiness / enterprise-level decision CDI, linked to OT EF COI's**
     - **Acquisition decision CDI, linked to acquisition**

Developing the DT EF (continued)

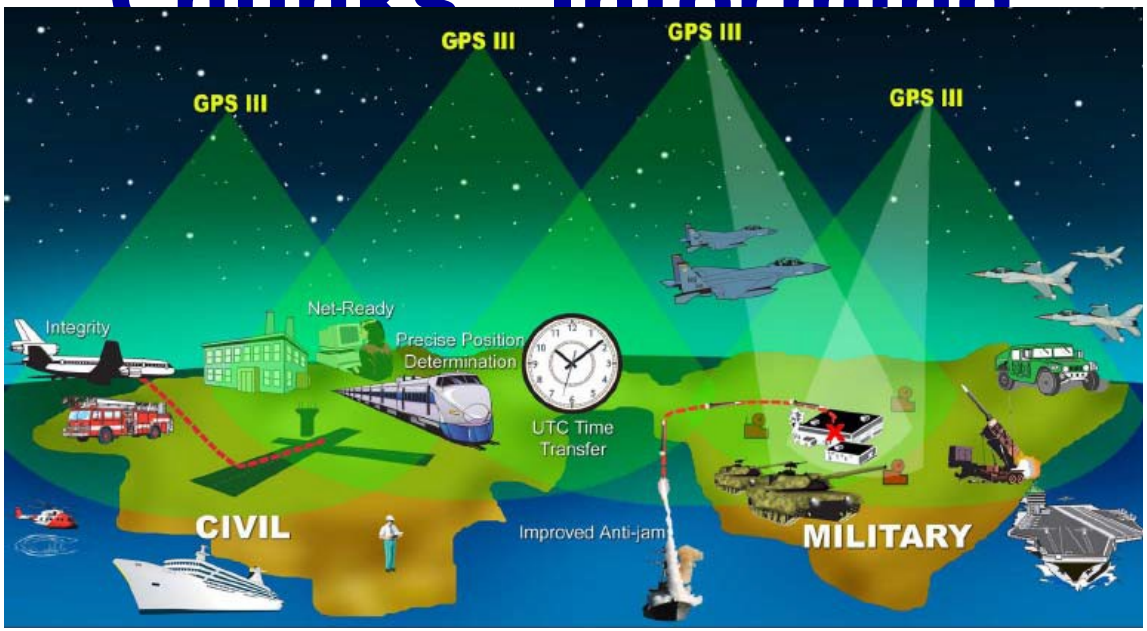
3. **Develop Developmental Test Objectives (DTO)**
   - Technical capabilities
   - Suggested starting point: major TRD paragraph headings
   - Expand or contract to generate top-level listing of technical capabilities

5. **Determine appropriate aggregation level for measures (i.e., cell content)**
   - Depending upon number of technical requirements, options:
     - Technical measures
     - TRD sub-paragraph (binning of several related measures)
     - DOORS hierarchy-cut
     - Binning of related measures

Example – GPS Enterprise

Global Positioning System (GPS) Enterprise modernization : satellite (GPS III), control segment (OCX), user equipment (MGUE)

COI's – Operational Mission "Chunks" Informing



Mission: GPS provides precise information to properly equipped users in support of specific mission objectives

Can GPS ***broadcast PNT*** data that supports the mission of properly equipped users?
Can the ***warfighter employ*** PNT data?
Does GPS ***command, control, and monitoring*** support all functions of GPS operations?

Does GPS provide MP in ***EW environments*** to properly equipped users?
Does GPS ***sustainment*** support mission operations?

CDI's – Technical System "Chunks" Informing Acquisition Decisions

Can GPS provide accurate PNT data to users?

Does GPS support NAVWAR operations?

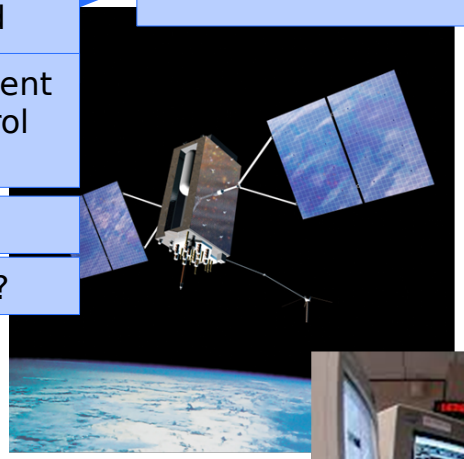
Can GPS support secondary payload missions?

Can the control segment command and control the constellation?

Is GPS secure?

Is GPS sustainable?

Enterprise EF CDI – Guide cross-segment evaluation for operational readiness decisions



Segment EF CDI – Guide evaluation for segment acquisition decisions

Can MGUE support both legacy and modernized signals?

Can MGUE be integrated into lead platforms to support msn ops?

Is MGUE secure?

Can MGUE operate in a NAVWAR environment?

Is MGUE sustainable?

GPS OT Evaluation Framework

GPS provides precise information to properly equipped users in support of specific mission objectives.					
Operational Capabilities	COI 1: Can GPS broadcast PNT data that supports the mission of properly equipped users?	COI 2: Can the warfighter employ PNT data?	COI 3: Does GPS command, control, and monitoring support all functions of GPS operations?	COI 4: Does GPS provide MP in EW environments to properly equipped users?	COI 5: Does GPS sustainment support mission operations?
System Autonomy	MOE 1.1				
Position Accuracy	MOE 1.2* - 1.3	MOE 2.1* - 2.2.1*			
Timing Accuracy	MOE 1.4*, 1.4.1*	MOE 2.3*, 2.3.1			
Signal Integrity			MOE 3.1 - 3.2*, 3.3 - 3.4*, 3.5 - 3.8		
Jam Resistance				MOE 4.1* - 4.1.2	
Signal Accessibility		MOE 2.4, 2.4.1		MOE 4.2	
NAVWAR		MOE 2.5*, 2.5.1	MOE 3.9, 3.25, 3.25.1	MOE 4.3 -4.4* 4.5 - 4.7, 4.8*, 4.9	
Signal Security		MOE 2.8*	MOE 3.10		
E3 Compatibility		MOE 2.6	MOE 3.11		
Constellation Management			MOE 3.12* - 3.18		
Interoperability		MOE 2.7*			
IA			MOE 3.19*, 3.20*, 3.21*, 3.22*		
Operations Continuity			MOE 3.23 - 3.24		
Usability					MOS 5.1 - 5.3
Reliability					MOS 5.4
Maintainability					MOS 5.5 - 5.6
Availability					MOS 5.7*
SV Readiness/ Disposal					MOS 5.8
Training Quality					MOS 5.9 - 5.14
Documentation					MOS 5.15 - 5.18
Logistics Supportability					MOS 5.19 - 5.21
UE Survivability					MOS 5.22
Training Compliance					MOS 5.23 - 5.26

Mission & COIs

OT Objectives

OT Measures

GPS Enterprise DT Evaluation Framework

CDIs

DT Objectives

DT Measures

Critical Developmental Issues (Enterprise) / Developmental Test Objectives	Can GPS provide accurate PNT data to users?	Does GPS support NAVWAR operations?	Can GPS support secondary payload missions?	Can the control segment command and control the constellation?	Is GPS secure?	Is GPS sustainable?
Backwards Compatibility						
Interfaces						
Position, Velocity, and Time (PVT)	User Range Error (URE) Analysis			User Range Error (URE) Analysis		
Signal-in-Space				Text Message Transmit Times Analysis		
Additional Payloads						
Constellation Operations						
Launch Operations						
Security						
Architecture Design						
Logistics Support						Logistics-PM&P and Accessibility
Personnel Requirements						
System Simulator and Training Requirements						

Document Evaluation & Test in TEMP

- **DAG's "Top Level Evaluation Framework"**
  - **Ops ✉ tech reqmt correlation**
- **DT Evaluation Framework**
  - **Evaluation plan against technical requirements**
- **OT Evaluation Framework**
  - **Evaluation plan against operational requirements**

Table 3-3. Top-Level Evaluation Framework for GPS III and OCX

OCX/GPS III Capability (GPS III CDD)	OT Measure	System CTP	GPS III CTP	OCX CTP	Methodology	Key Resources	Test Events
Availability of Position Accuracy* (6.3.3)	MOE 1.2	Availability of Position Accuracy	SIS URE, SIS TKS Stability, SIS MMD/Reliability, SIS Availability	Zero Age of Data URE 24-hr Age of Data URE	**DT: 24hr and 1hr URE analysis of actual SIS data from monitor stations.** **OT: Independent analysis of data collected during DT.** **TPM Tracking** SS-SYS-(194,7269,7369,8665,8682,8686,7236): System TPM PNT-1 (Availability of Position Accuracy) SS-SS-(1598,1600,4706): Space Segment TPM SS-04 (Signal in Space User Range Error) SS-CS- (3519,3749,3750,3751,3752): Control Segment TPM NAV002 (24-hr Age of Data URE) SS-CS- (3527,3775,3776,3777,3778): Control Segment TPM NAV001 (Zero Age of Data URE)	International GNSS Service (IGS) monitor station data, precise ephemeris truth data, and analysis tools.	IST 3-1 OCX & GPS III OUE IST 3-2 CM OUE
Availability of Time Transfer Accuracy* (6.3.6)	MOE 1.4	Availability of Time Transfer Accuracy	NA	Zero Age of Data URE, 24-hr Age of Data URE	Analysis of parameter estimates and time offset between GPS and USNO. **TPM Tracking** SS-SYS- 233: System TPM PNT-2 (Availability of Time Transfer Accuracy) SS-CS-440: Control Segment TPMs NAV001 (Zero Age of Data URE) and NAV002 (24-hr Age of Data URE)	Monitor station data, USNO-generated UTC time offset, analysis tools.	IST 3-1 OCX & GPS III OUE IST 3-2 CM OUE
					Analysis of User Range Accuracy (URA) data. **TPM Tracking**	pace and control tegrity analysis sta of URA ounds.	IST 3-1 OCX & GPS III OUE IST 3-2 CM OUE

Critical Developmental Issues (Enterprise) / Developmental Test Objectives	Can GPS provide accurate PNT data to users?	Does GPS support NAVWAR operations?	Can GPS support secondary payload missions?	Can the control segment command and control the constellation ?	Is GPS secure?	Is GPS sustainable?
Backwards Compatibility						
Interfaces						
Position, Velocity, and Time (PVT)	User Range Error (URE) Analysis			User Range Error (URE) Analysis		
Signal-in-Space				Text Message Transmit		
Additional Payloads						
Constellation Operations						
Launch Operations						
Security						
Architecture Design						
Logistics Support						
Personnel Requirements						
System Simulator and Training Requirements						

Mission Statement: CSAR-X supports the combat search and rescue mission

* = KPP
Effectiveness Centric
Suitability Centric

Operational Capabilities	COI 1: Can CSAR-X recover personnel?	COI 2: Can CSAR-X operate in the battlespace?	COI 3: Does CSAR-X mission planning support COCOM taskings?	COI 4: Does CSAR-X generation support COCOM taskings?	COI 5: Does CSAR-X deployment and sustainment support operations worldwide?
Extraction Flexibility	6.2, 6.10				
Payload Adaptability	6.9, 6.23				
Survivability	6.5 – 6.8	6.5 – 6.8			
Persistence		6.13			
Timeliness	10.3*		10.3*		
Accuracy	6.12	6.12	6.4*, 8.3		
Compatibility	6.3.1*, 6.25	3.2, 6.3, 6.25, 13.8, 16.3	8.3, 9.3	13.8.6	
Interoperability	6.3*, 6.25	6.3*, 6.21, 14.15	6.3*, 8.3, 9.3	14.15	
Reliability		14.21		6.15.2*	
Maintainability				6.16*, 13.8.14	
Supportability	10.3*	10.3*	9.1	13.8.1, 13.8.15	3.1.6, 13.8.1, 13.8.5, 13.8.15
Responsiveness				3.1.3, 6.4, 6.15*, 6.18, 13.8.16	6.14, 6.15*, 13.8.16
Availability				6.14	6.15*
Sustainability					3.1.2, 13.1.1

Then Plan the Test *or* Bring it Back Together as IT

Each T&E community, evaluation frameworks in hand, return to the ITT table to develop integrated test events

- **Integrated test (IT) events generate data**
- **IT data feeds independent evaluation & reporting**
- **To define technical and operational capabilities**
- **To inform developmental and**

Applying STAT (DOE) to the IT

With EF in hand and STAT in their quiver, DT&E and OT&E planners can design efficient integrated tests

- **Align common DT&E and OT&E objectives**
- **Compare measures, factors, levels**
- **Define input, process, output (IPO) diagram**
  - **Process: Common objective**
  - **Input: Common factors/levels**
  - **Output: DT or OT measures**

IT Design – Objective Com

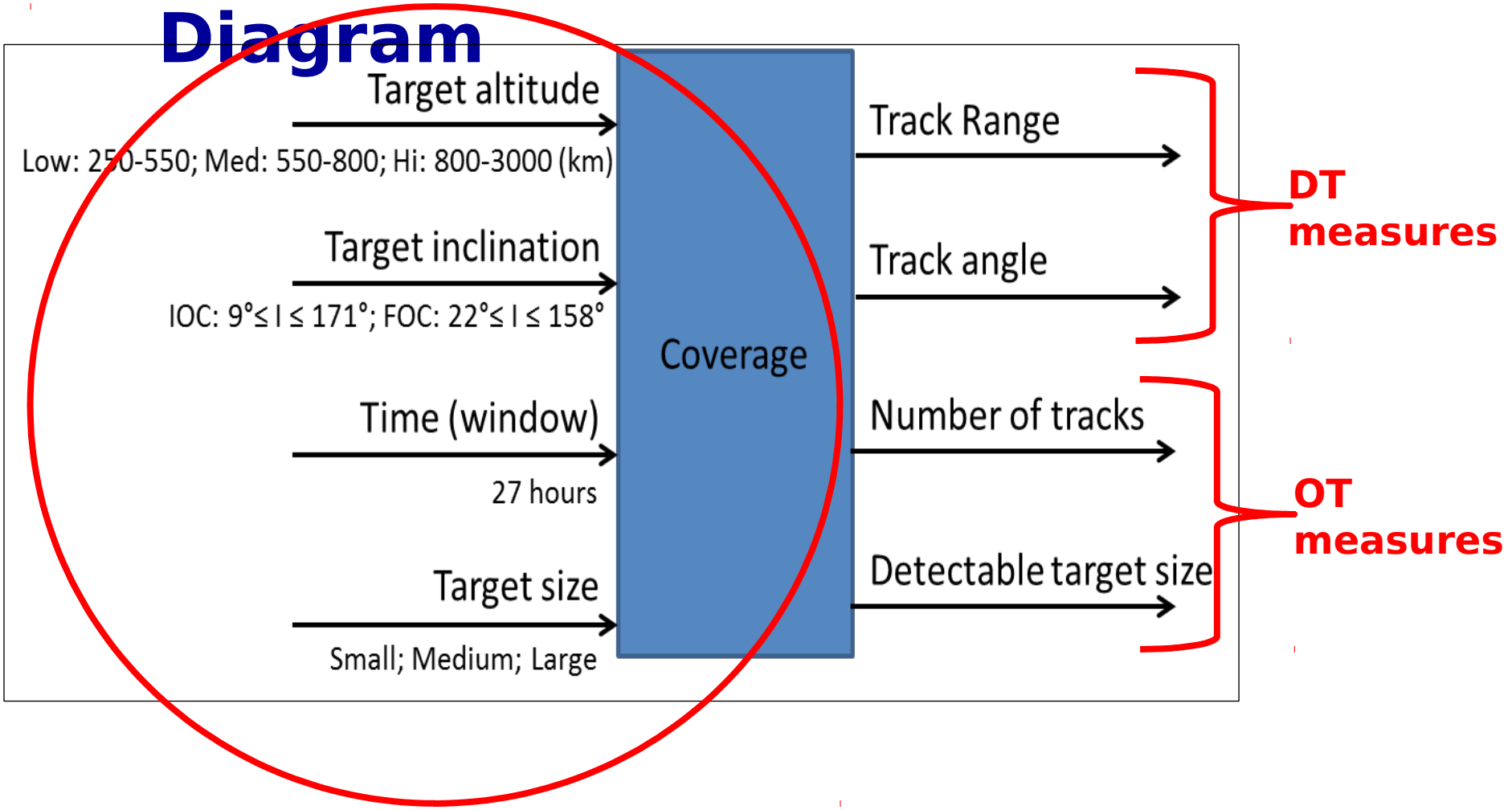
Objective (Capability)	Measure Description	Measure Quantitative Value	Factors	Note
OT&E				
Coverage	Number of tracks per object (KPP)	#vary by altitude (CDD Table 6-1, pg25)	Altitude, Inclination, Cued, Uncued, Time (27 hour period), Orbit shape	
	Number of objects simultaneously tracked	≥200		Similar DT measure in Capacity objective
	Detectable target size (KPP)		Size, altitude	
	Object discrimination	"best available"		Similar DT measure in Sensitivity objective
DT&E				
dar coverage	Range	Min =100Km, Max ≥40K Km		TRD Para 3.1.4.5.1 pg 18
	Track angle	±70 degrees		
	Configurable	Operator configurable		
	LEO Uncued surveillance coverage		Altitude, Inclination, Time (27 hour period), Orbit shape	
	LEO Cued surveillance coverage		Altitude, Inclination, Time (27 hour period), Orbit shape	
	Coverage flexibility	Enhanced sensitivity over a settable region in space to meet LEO performance requirements	Target size, polarization, altitude	TRD Table 3, pg 20 Measure may be a better fit in Sensitivity DT Obj

Common DT and OT objectives (process)

Associated measures (output)

Common factors & levels (input)

IT Design Example – IPO Diagram



mmon DT & OT objective, factors, levels create test design

Closing the Loop – Evaluate &

Evaluate test-generated technical performance data to inform program's acquisition and operational decisions

- **Develop a DT&E evaluation taxonomy**
  - **Evaluate technical performance, to include**
    - **Analyze performance against technical measures**
    - **Weight performance against CTP's more heavily**
    - **Include technical performance against criteria, DR's, technical /engineering judgment**
  - **Provide performance summary as decision-quality information**
    - **Inform at objective, CDI level**
    - **Properly-crafted Evaluation Framework tells the technical performance story clearly and concisely**

Summary

- DT EF focuses technical evaluation (in mission context) to inform acquisition decisions
  - CDI ✉ DT Objectives ✉ TPM (some are CTP)
- OT EF focuses operational evaluation to inform operational effectiveness, suitability, & mission capability
  - COI ✉ OT Objectives ✉ MOE/MOS (some are KPP, KSA)
- Design test plans to generate data that feeds EF
  - Use STAT / DOE to design rigorous and complete

Develop evaluation framework (EF) to guide system evaluation, test planning, and analysis – in that order

BACK-UP

GPS III DT Evaluation Framework

CDIs

DT Objectives

Critical Developmental Issues (GPS III) / Developmental Test Objectives	Can GPS III SV01 support both legacy and modernized signals?	Can GPS III SV09-20 support legacy, modernized signals, and on-ramp capabilities?	Can GPS III support hosted payloads?	Can GPS III support NAVWAR operations?	Is GPS III secure (i.e. crypto)?	Is GPS III sustainable?
Backwards Compatibility	SS-SS-?? Title notionally at the 4-level paragraph heading.					
Interfaces	**Bold the TPMs (CTPs)**					
Position, Velocity, and Time (PVT)						
Signal-in-Space						
Additional Payloads						
Constellation Operations						
Launch Operations						
Security						
Architecture Design						
Logistics Support						
Personnel Requirements						
System Simulator and Training Requirements						

T
ures

GPS OCX DT Evaluation Framework

CDIs

DT Objectives

DT Measures

Critical Developmental Issues (OCX) Developmental Test Objectives	Can the control segment (LCC/LCS) support launch and early orbit checkout of GPS III SV01?	Can OCX Block 1 replace AEP and LADO, and command L2C & L5?	Can OCX Block 2 command legacy and modernized signals (M-code and L1C)?	Can OCX support NAVWAR operations?	Is OCX secure (i.e. IA, Crypto, Anti-Tamper, Physical, and Integrity)?	Is OCX sustainable?
Backwards Compatibility	SS-CS-?? Title notionally at the 4-level paragraph heading.					
Interfaces	**Bold the TPMs (CTPs)**					
Position, Velocity, and Time (PVT)						
Signal-in-Space						
Additional Payloads						
Constellation Operations						
Launch Operations						
Security						
Architecture Design						
Logistics Support						
Personnel Requirements						
System Simulator and Training Requirements						

GPS MGUE DT Evaluation Framework

CDIs

DT Objectives

DT Measures

Critical Developmental Issues (MGUE) Developmental Test Objectives	Can MGUE support both legacy and modernized signals?	Can MGUE be integrated into lead platforms to support mission operations?	Is MGUE secure (i.e. Anti-Tamper, Anti-Spoof, Crypto)?	Can MGUE operate in a NAVWAR environment ?	(TBD) Is MGUE sustainable?
Backwards Compatibility	MGUE TRD Title notionally at the ?-level paragraph heading.				
Interfaces	**Bold the TPMs (CTPs)**				
Position, Velocity, and Time (PVT)					
Signal-in-Space					
Additional Payloads					
Constellation Operations					
Launch Operations					
Security					
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